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Stereoselective Alkylation of Cyclic and Acyclic Chiral β-Enamino Ketones Lithium Dianions: Synthesis of Either (*R*)- or (*S*)-Chiral 1,3-Diketones.

Giuseppe Bartoli,[a] Marcella Bosco,[b] Cristina Cimarelli,[a]
Renato Dalpozzo,[c] Giovanni De Munno,[c] and Gianni Palmieri [a,*]

[a] *Dipartimento di Scienze Chimiche, via S. Agostino 1, I-62032 Camerino (MC) Italy,*
[b] *Dipartimento di Chimica Organica "A. Mangini", viale Risorgimento 4, I-40136 Bologna, Italy,*
[c] *Dipartimento di Chimica, Università della Calabria, I-87030 Arcavacata di Rende (CS), Italy.*

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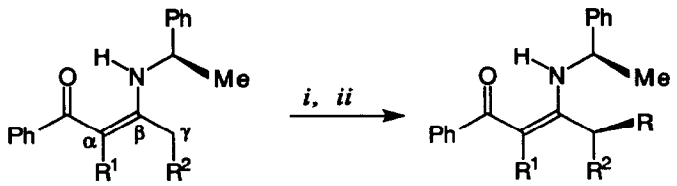
Abstract: The synthesis of either (*R*)- or (*S*)-chiral 1,3-diketones through asymmetric γ alkylation reaction of cyclic and acyclic chiral β-enamino ketones was here performed. The alkylation takes place with good yields and high *d.e.* in HMPA/THF. Both the pure enantiomers of 1,3-diketones can be formed by simple hydrolysis of the epimeric β-enamino ketones obtained with this method, choosing the suitable synthetic strategies. An explanation of the asymmetric induction was proposed.

The reaction of enolate ion with carbon electrophile represents the most classical approach to C-C bond formation α to a CO group of aldehydes and ketones.[1] More recently metallated imines, have been used extensively as advantageous reactive enolate equivalents.[2] This has solved many of the problem associated with the classical carbonyl chemistry, such as aldol type self condensation, di- and polyalkylation, control of regiochemistry, side reaction of products.[3] Among the most important advantages of the imine (and other N derivatives of carbonyl compounds) is the ability to introduce a "stereogenic center" via an enantiomerically pure amine or its derivative, thus enabling diastereoselective control of the C-C bond forming process.[4,5] Meyers el al.[4a-c] reported that a chelatable donor substituent in the chiral amine is essential for an high *d.e.* in the final product through the rigid five membered chelate ring of the lithioimine intermediate. The ability of lithium cation to coordinate the R-X addresses the entering electrophile to attack the azaallylic anion from the same side of the lithium atom. Recent works [5] showed that it is not necessary to start from amines having a chelatable substituents. In fact very satisfactory results can be obtained by using less complex and commercially available material such as 1-phenylethylamine or 1-naphtylethylamine. In these cases it is necessary to carry out the reaction in the presence of strong complexing agent of lithium cation such as N,N'-dimethylpropyleneurea (DMPU) or hexamethylphosphoric triamide (HMPA).

We have recently reported on the highly efficient regiospecific functionalization of β-monoalkylamino-α,β-unsaturated ketones.[6] This was obtained by the reaction of the regiospecifically prepared α'- or γ-dianion of β-enamino ketones with electrophiles. Using the optically pure amine to form the enaminone we have developed the stereoselective synthesis of chiral 1,3-diketones, through the diastereoselective γ-alkylation of the intermediate chiral aza-dienolate. Enantiomerically pure 1,3-diketones can be obtained by mild acidic hydrolysis of the so alkylated enaminones.

Table 1. Diastereoselective alkylation of enaminone **1a-e** with different alkyl halides.



1a-e **2aa-ed**

i: 2.5 MeLi/2.5 HMPA/THF, 0 to 30°C, 30'; *ii*: 1.5 RX/THF, -100°C, 30'.

1	R^1	R^2	R-X	2	Yield (%)[a]	*d.e.*[b]	(config.)[c]
1a	$(CH_2)_2$		Me-I	**2aa**	93	27	(*S*)
1a	$(CH_2)_2$		Et-I	**2ab**	87	74	(*S*)
1a	$(CH_2)_2$		Bu-I	**2ac**	85	87	(*S*)
1a	$(CH_2)_2$		Bn-Cl	**2ad**	89	68	(*R*)
1a	$(CH_2)_2$		Pr^i-I	**2ae**	75	93	(*R*)
1b	$(CH_2)_3$		Me-I	**2ba**	77	34	(*S*)
1b	$(CH_2)_3$		Et-I	**2bb**	82	98	(*S*)
1b	$(CH_2)_3$		Bu-I	**2bc**	79	98	(*S*)
1c	H	Me	Et-I	**2cb**	95	92	(*R*)
1c	H	Me	Bn-Cl	**2cd**	91	90	(*R*)
1c	H	Me	Pr^i-I	**2ce**	88	98	(*R*)
1d	H	Bn	Me-I	**2da**	93	85	(*S*)
1d	H	Bn	Et-I	**2db**	85	93	(*S*)
1d	H	Bn	Pr^i-I	**2de**	91	95	(*R*)
1e	H	Pr^i	Me-I	**2ea**	87	31	(*S*)
1e	H	Pr^i	Et-I	**2eb**	84	94	(*S*)
1e	H	Pr^i	Bn-Cl	**2ed**	89	87	(*S*)

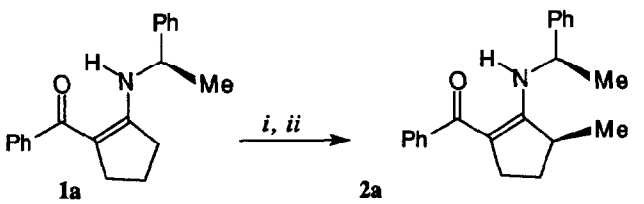
[a] Combined yields of both diastereomers. [b] Determined by HPLC-MS analysis of purified but unresolved mixtures. [c] Configuration at the γ-carbon atom of the prevalent diastereomer.

Interesting preliminary results have been obtained performing the reaction on chiral cyclic β-[N-(*R*)-1-phenylethyl]amino-α,β-unsaturated ketones as **1a,b**.[7] The good yields and high diastereoisomeric excess obtained prompted us to extend the reaction to acyclic chiral β-enamino ketones **1c-e**. Lithium dianion was prepared by treatment of enaminone in THF with 2.5 eq. of methyl lithium in the presence of 2.5 eq. of HMPA

from 0 to 30 °C for 30'. Then the cooled mixture (-100 °C) was treated with 1.5 eq. of alkyl halide. Usual work-up gave the pure γ-alkylated enamino ketone **2aa-ed**. As showed in the Table 1 , high yields and good *d.e.* have been obtained for the reaction of enaminones **1a-e** with a large variety of alkyl halides. Using methyl iodide as electrophile, only, we have obtained low *d.e.* because of the small size of the entering methyl group. The *d.e.* increases with increasing the steric hindrance of the entering alkyl group.

We preferred (*R*)-1-phenylethylamine as chiral source because is a very cheap and common amine, commercially available in both the pure enantiomers; in our system it gives very high *d.e.* as showed in the Table 1. We obtained an enhanced reactivity and the best d.e. using HMPA as additive, precisely in equimolecular amount to the MeLi. The use of a deficit or an excess of HMPA causes a consistent stereoselectivity decrease. Different ligand agents tested (HMPT (hexamethylphosphorous triamide), Et_3N, TMEDA) gave less satisfactory results as showed in Table 2.

Table 2. Optimization of methylation of **1a** to **2a**: solvent effects.



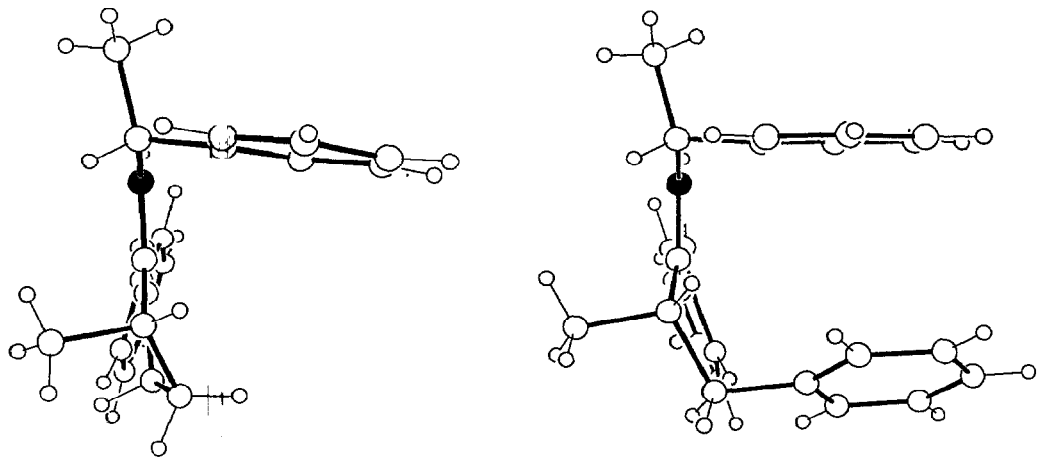
1a **2a**

i: 2.5 MeLi/additive/THF, 0 to +30°C, 30'; *ii*: 1.5 MeI/THF, -100°C, 30'.

entry	additive	mol equiv	yield (%)	*d.e.*
1	HMPA	1.25	88	2
2	HMPA	2.5	93	27
3	HMPA	5	91	19
4	HMPA	10	93	14
5	HMPT	2.5	82	23
6	Et_3N	2.5	12	11
7	TMEDA	2.5	20	18

The absolute configuration of the new chiral γ carbon atom in the isolated pure diastereomers was previously determined on the basis of ^{1}H-NMR spectroscopic experiments and subsequently confirmed by X-ray analysis, performed on the enaminone **2aa** and **2da** (additional material were supplied). In all the diastereomeric enaminones examined a strong n.O.e. effect between the benzylic hydrogen of the chiral amine (H-benzylic) and H-γ or R-γ was observed (ROESY). These findings support that the stable conformation in $CDCl_3$ solution is the same assumed in the crystal (see X-ray structure for **2aa** and **2da** depicted in Fig. 1) were H-benzylic is located near H-γ and R-γ. Moreover in the stable conformation the phenyl group of the amine exerts a shielding effect on the neighboring groups attacked to γ carbon atom. This shielding effect, observed in all the diastereomers, is of about 0.3 ppm, with respect to the corresponding signal of the epimers and were used for the attribution of the configuration of all the diastereomers.

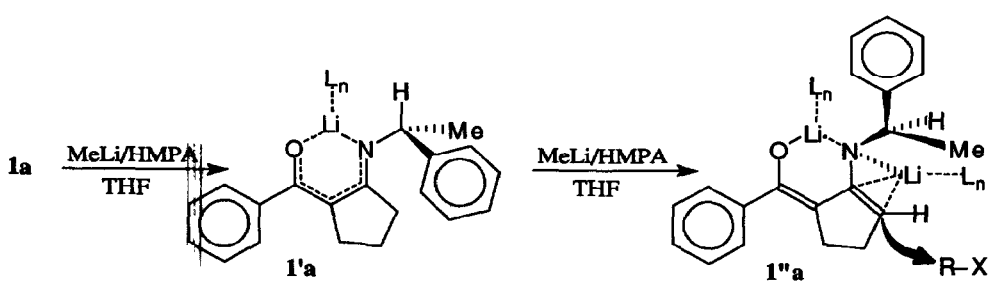
Figure 1. X-ray structures of cyclic (γ-*S*)-**2ae** and acyclic (γ-*S*)-**2da** enaminones.



(γ-*S*)-**2ae** (γ-*S*)-**2da**.

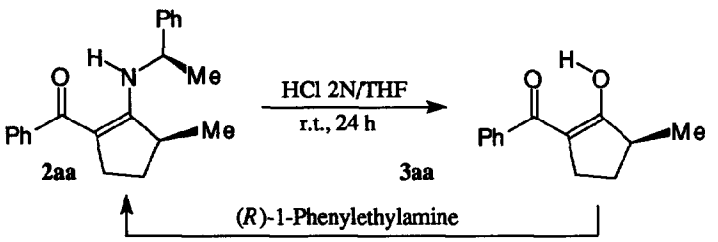
A possible explanation of the asymmetric induction can be proposed examining the steric aspect in the formation process of the chiral enaminone lithium dianion **1"a** (see Scheme 1). In this medium the lithium enaminones are present as reactive monomers, coordinated with HMPA and THF.[4d,5b,8] The first coordinated lithium ion in the monoanion **1'a** resides in the molecular plane, chelated between O and N, constraining the aza-allylic sistem in the *syn* configuration and providing the conformational rigidity necessary for an high asymmetric induction. The configuration of the chiral substituent at the N atom addresses the second metallation process to the less hindered side (back face of **1'a** in the case of the (*R*)-amine). In the dianion **1"a** the *re* face of the azaallylic system is highly hindered by the second lithium atom strongly coordinated with the bulky an powerful ligand, HMPA, preventing the attack of the electrophile on the same face. Thus the approach of the alkyl halide would take place preferentially from the *si* face. The powerful ligand HMPA, coordinated with lithium atom, would increase the nucleophilicity of the enaminone system.

Scheme 1 - Formation process of the chiral enaminone lithium dianion **1"a**.



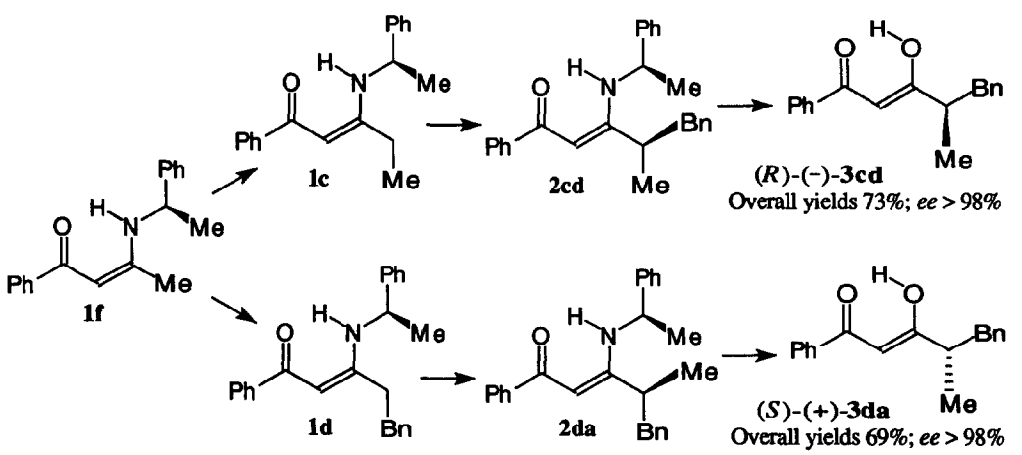
The chiral 1,3-diketone **3aa** is easily obtained by hydrolysis of the corresponding β-enamino ketone **2aa** in 2N acqueous HCl/THF mixture for 24 hours at r.t. (see Scheme 2). We verified that the chiral β-diketone does not racemize during the hydrolysis process. In fact if the 1,3-diketone **3aa**, recovered from the hydrolysis process, was treated with an equimolecular amount of (*R*)-1-phenylethylamine[10] we obtained, with 98% d.e., the same diastereoisomer **2aa** used to perform the hydrolysis. A further demonstration cames from the polarimetric analysis of the same 1,3-diketone **3aa** dissolved in the hydrolytic mixture used for its preparation. The optical activity remains unaltered for several days, showing that the environment is not racemizing.

Scheme 2 - Hydrolysis of the enamino ketones to chiral 1,3-diketones



It's possible to perform the asymmetric synthesis of both the enantiomers of chiral 1,3-diketones, simply changing the chiral amine or the order of the two alkylations when this is possible. For example: it is possible to prepare the (*R*)-β-diketone **3cd** from enaminone **1f** performing, both in the γ position, first the methylation and subsequently the benzylation. Inverting the order of alkylation we can obtain the (*S*)-enantiomer **3da**. The same results could be obtained performing the hydrolysis of the epimeric diastereomers **2ce-2ea** and **2de-2ed**.

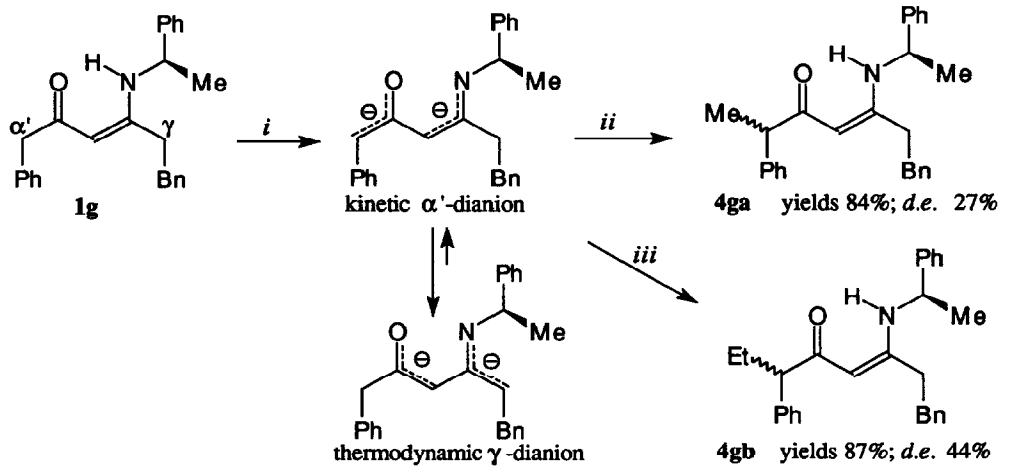
Scheme 3 - Synthesis of both antipodes of chiral 1,3-diketones.



Several attempts were made to extend the reaction to enaminone which can be metallated both in γ or in α'-position failed. We studied recently the conditions for a regiospecific metallation: using the MeLi/TMEDA couple in THF, we obtained the thermodynamically more stabile dianion (γ), while using as metallating agent the LiTMP in THF we obtained mainly the kinetic dianion (α') that slowly changes in the thermodynamic one (γ).[6] Unfortunately the systems we have studied for a maximum of stereoselectivity gave a low regioselectivity because the steric factors are prevalent on the electronic ones. The γ-position in fact, is strongly hindered by the chiral centre, so that the alkylation take place preferentially on the α' position even if the metalation were performed in the optimum conditions to achieve γ alkylation.

In the example reported in Scheme 4 we can alkylate chiefly in α' position. As expected, EtI gave better results than MeI but lower *d.e.* were however obtained due to the long distance between the reaction center and the chiral source.(the configuration of the prevalent diastereomers were not assigned)

Scheme 4 - α' diastereoselective alkylation of enaminone **1g** lithium dianion.



i: 2.5 MeLi/2.5 HMPA/THF, 0 to 30°C, 30'; *ii*: 1.5 MeI/THF, -100°C, 30'; *iii*: 1.5 EtI/THF, -100°C, 30'.

In conclusion, γ asymmetric alkylation of the chiral enaminone lithium dianion takes place in HMPA/THF with good yields and high *d.e.* In the same conditions the α'-alkylation takes place with low *d.e.* The operational simplicity of this method take advantages in providing a variety of alkylated products in quite high stereoisomeric purity, wherein the absolute configuration can be predicted with a great grade of confidence. Either antipodes of chiral 1,3-diketones can be obtained by simple hydrolysis of the epimeric β-enamino ketones synthesized choosing the opportune strategies.

EXPERIMENTAL SECTION

^{1}H and ^{13}C-NMR spectra were recorded with a Varian VXR 300 instrument. Chemical shifts are given in ppm downfield from Me_4Si in $CDCl_3$ solution. Coupling constants are given in Hertz. IR spectra were recorded with a Perkin-Elmer 257 spectrometer. GC-MS analyses were performed with an HP 59970 workstation formed by an HP-5890 gas chromatograph equipped with a methyl silicone capillary column and by an HP-5970 mass detector. THF were dried by refluxing over sodium wires until the blue colour of benzophenone ketyl persisted and then distilling into a dry receiver under nitrogen atmosphere. Commercial methyllithium and butyllithium solutions (Aldrich) were employed under dry atmosphere. Commercial HMPA, TMEDA and TMP (Aldrich) were distilled and dried before use. The *(R)*-(+)-1-phenylethylamine 98% $[\alpha]^{23}$ +38°(neat) were purchased from Aldrich and used without further purification.

Preparation of starting enaminones 1a-g.

The enaminone **1f** were prepared from benzoylacetone and *(R)*-1-phenylethylamine according to Singh and Tandon's procedure.[10]

(R)-1-Phenyl-3-[N-(1-phenylethyl)-amino]-but-2-en-1-one *(R)*-**1f.**

M.p. 70-71 °C (Hexane) $[\alpha]_D^{20}$ = -803.5 (c 1.0, $CHCl_3$). (Found: C, 81.41; H, 7.13; N, 5.22. $C_{18}H_{19}NO$ requires: C, 81.48; H, 7.22; N, 5.28 %). ^{1}H-NMR δ 1.62 (d, J=6.8, 3H, Me-CH), 1.94 (s, 3H, H-γ), 4.76 (dq, J=7.1, 6.8, 1H, N-CH), 5.72 (s, 1H, H-α), 7.22-7.48 (m, 8H), 7.88-7.93 (m, 2H), 11.85 (broad d, J=7.1, 1H, NH). ^{13}C-NMR δ 19.80 (q), 24.80 (q), 53.39 (d), 92.54 (d), 125.62 (d), 126.95 (d), 127.30 (d), 128.19 (d), 128.92 (d), 130.56 (d), 140.29 (s), 144.10 (s), 164.44 (s), 188.01 (s). IR ν_{max}(nujol) 3300 (broad), 1585, 1430, 1280, 725, 690 cm^{-1}. MS m/z (%): 265 (M^+,57), 160 (77), 105 (100), 77 (48).

The enaminones **1a,b,g** were prepared from the appropriate esters and the lithium anion of the *(R)*-1-phenylethylimines according to our procedure previously reported.[9]

(R)-1-benzoyl-2-[N-(1-phenylethyl)]-aminocyclopentene *(R)*-**1a.**

Oil $[\alpha]_D^{20}$ = -588.3 (c 1.1, $CHCl_3$). (Found: C, 82.57; H, 7.31; N, 4.86. $C_{20}H_{21}NO$ requires: C, 82.44; H, 7.26; N, 4.81 %). ^{1}H-NMR δ 1.58 (d,J=6.67, 3H), 1.64-1.87 (m, 2H, H-4), 2.30 (ddd, J=17.1, 8.7, 6.7, 1H, H-3), 2.59 (ddd, J=17.1, 8.5, 6.4, 1H, H-3), 2.72 (t,J=7.0, 2H, H-5), 4.66 (dq, J=6.9, 7.6, 1H, N-CH), 7.20-7.45 (m, 8H), 7.65-7.75(m, 2H), 10.87 (broad d, J=7.6, 1H, NH). ^{13}C-NMR δ 22.56 (t), 24.50 (q), 31.29 (t), 31.68 (t), 54.61 (d), 104.46 (s), 125.41 (d), 127.00 (d), 127.05 (d), 127.55 (d), 128.56 (d), 129.23 (d), 141.88 (s), 143.93 (s), 169.75 (s), 188.55 (s). IR ν_{max}(liquid film) 3400 (broad), 1600, 1525, 1320, 1280, 690 cm^{-1}. MS m/z (%): 291 (M^+,68),276 (18), 186 (100), 105 (89).

(R)-1-benzoyl-2-[N-(1-phenylethyl)]-aminocyclohexene *(R)*-**1b.**

Oil $[\alpha]_D^{20}$ = -388.2 (c 1.0, $CHCl_3$). (Found: C, 82.73; H, 7.73; N, 4.54. $C_{21}H_{23}NO$ requires: C, 82.59; H, 7.59; N, 4.59 %). ^{1}H-NMR δ 1.58 (d, J=6.8, 3H, Ph-CH-Me), 1.40-2.60 (m, 8H), 4.75 (dq, J=7.1, 6.8, 1H, N-CH), 7.20-7.60 (m, 8H), 7.85-7.95(m, 2H), 11.25 (broad d, J=7.1, 1H, NH). ^{13}C-NMR δ 23.95 (t), 25.35 (q), 27.22 (t), 28.87 (t), 29.90 (t), 54.68 (d), 102.67 (s), 127.75 (d), 128.76 (d), 129.19 (d), 129.88 (d), 130.37 (d), 130.92 (d), 145.00 (s), 146.71 (s), 166.03 (s), 196.33 (s). IR ν_{max}(nujol) 3350 (broad), 1580, 1445, 1275, 1135, 695 cm^{-1}. MS m/z (%): 305 (M^+,16), 200 (100), 105 (81), 77 (29).

(R)-1,6-diphenyl-4-[N-(1-phenylethyl)]-amino-hex-3-en-2-one (*R*)-**1g**.

Oil $[\alpha]_D^{20} = -322.8$ (c 1.7, $CHCl_3$). (Found: C, 84.72; H, 7.48; N, 3.62. $C_{26}H_{27}NO$ requires: C, 84.51; H, 7.37; N, 3.79 %). ^{1}H-NMR δ 1.48 (d, J=6.7, 3H, Ph-CH-Me), 2.26-2.47 (m, 2H), 2.55-2.77 (m, 2H), 3.64 (s, 2H, CH_2-α'), 4.59 (dq, J=7.1, 6.7, 1H, N-CH), 5.60 (s, 1H, H-α), 6.95-7.40 (m, 15H),11.40 (broad d, J=7.1, 1H, NH). ^{13}C-NMR δ 24.94 (q), 33.78 (t), 34.41 (t), 49.14 (t), 52.87 (d), 94.13 (d), 125.58 (d), 126.28 (d), 126.36 (d), 127.28 (d), 128.21 (d), 128.31 (d), 128.43 (d), 128.51 (d), 128.65 (d), 128.87 (d), 128.95 (d), 129.42 (d), 137.31 (s), 140.25 (s), 144.39 (s), 166.25 (s), 195.28 (s). IR ν_{max}(film) 3300 (broad), 1575, 1555, 1300, 1110, 750, 710, 695 cm^{-1}. MS m/z (%): 278 (M^+-91, 74), 174 (65), 105 (100), 91 (26).

The enaminone **1c,d,e** were prepared by γ alkylation of enaminone **1f** according to our procedure previously reported.[6a]

(R)-1-Phenyl-3-[N-(1-phenylethyl)-amino]-pent-2-en-1-one (*R*)-**1c**.

Oil $[\alpha]_D^{20} = -722.4$ (c 1.1, $CHCl_3$). (Found: C, 81.59; H, 7.73; N, 5.14. $C_{19}H_{21}NO$ requires: C, 81.68; H, 7.58; N, 5.01 %). ^{1}H-NMR δ 1.10 (t, J=7.6, 3H, Me-δ), 1.61 (d, J=6.7, 3H, CH-Me), 2.17 (dq, J=14.9, 7.6, 1H, H-γ), 2.33 (dq, J=14.9, 7.6, 1H, H-γ), 4.78 (dq, J=7.3, 6.7, 1H, N-CH), 5.73 (s, 1H, H-α), 7.24-7.48 (m, 8H), 7.86-7.96 (m, 2H), 11.95 (broad d, J=7.3, 1H, NH). ^{13}C-NMR δ 12.23 (q), 25.02 (q), 25.48 (t), 52.78 (d), 90.33 (d), 125.59 (d), 126.93 (d), 127.27 (d), 128.17 (d), 128.87 (d), 130.49 (d), 140.56 (s), 144.32 (s), 169.44 (s), 188.32 (s). IR ν_{max}(liquid film) 3300 (broad), 1570, 1265, 725, 680 cm^{-1}. MS m/z (%): 279 (M^+,33), 174 (71), 105 (100), 77 (40).

(R)-1,5-Diphenyl-3-[N-(1-phenylethyl)-amino]-pent-2-en-1-one (*R*)-**1d**.

Oil $[\alpha]_D^{20} = -596.1$ (c 1.0, $CHCl_3$). (Found: C, 84.41; H, 6.93; N, 3.82. $C_{25}H_{25}NO$ requires: C, 84.47; H, 7.09; N, 3.94 %). ^{1}H-NMR δ 1.59 (d, J=6.9, 3H, Me-CH), 2.49 (ddd, J=14.0, 9.8, 6.1, 1H, H-δ), 2.57 (ddd, J=14.0, 9.2, 6.8, 1H, H-δ), 2.73 (ddd, J=13.4, 9.2, 6.1, 1H, H-γ), 2.85 (ddd, J=13.4, 9.8, 6.8, 1H, H-γ), 4.70 (dq, J=7.6, 6.9, 1H, N-CH), 5.78 (s, 1H, H-α), 7.09-7.50 (m, 13H), 7.88-7.96 (m, 2H), 12.02 (broad d, J=7.6, 1H, NH). ^{13}C-NMR δ 25.02 (q), 34.28 (t), 34.67 (t), 53.08 (d), 91.67 (d), 125.64 (d), 126.45 (d), 126.97 (d), 127.38 (d), 128.21 (d), 128.29 (d), 128.60 (d), 128.97 (d), 130.60 (d), 140.27 (s), 140.43 (s), 144.40 (s), 167.29 (s), 188.29 (s). IR ν_{max}(liquid film) 3300 (broad), 1570, 1430, 1300, 1120, 735, 685 cm^{-1}. MS m/z (%): 355 (M^+, 18), 264 (68), 250 (64), 105 (100), 91 (31), 77 (46).

(R)-1-Phenyl-3-[N-(1-phenylethyl)-amino]-5-methyl-hex-2-en-1-one (*R*)-**1e**.

M.p. 85-87 °C (Hexane) $[\alpha]_D^{20} = -682.5$ (c 1.0, $CHCl_3$). (Found: C, 82.21; H, 8.03; N, 4.42. $C_{21}H_{25}NO$ requires: C, 82.04; H, 8.20; N, 4.56 %). ^{1}H-NMR δ 0.92 (d, J=6.6, 3H, i-Pr), 0.98 (d, J=6.6, 3H, i-Pr), 1.61 (d, J=6.7, 3H, N-CH-Me), 1.89 (nonett, J=6.8, 1H, i-Pr), 2.02 (dd, J=13.6, 7.6, 1H, H_Aγ), 2.19 (dd, J=13.6, 6.8, 1H, H_Bγ), 4.79 (dq, J=8.5, 6.7, 1H, N-CH), 5.70 (s, 1H, H-α), 7.22-7.50 (m, 8H), 7.86-7.96 (m, 2H), 12.01 (broad d, J=8.5, 1H, NH). ^{13}C-NMR δ 22.41 (q), 22.77 (q), 24.98 (q), 27.86 (d), 41.54 (t), 52.95 (d), 92.64 (d), 125.54 (d), 126.89 (d), 127.21 (d), 128.12 (d), 128.82 (d), 130.43 (d), 140.48 (s), 144.24 (s), 167.21 (s), 187.77 (s). IR ν_{max}(nujol) 3300 (broad), 1575, 1560, 1435, 1275, 740, 685 cm^{-1}. MS m/z (%): 307 (M^+, 29), 202 (32), 188 (15), 160 (37), 105 (100).

General procedure for the diastereoselective alkylation of the enaminone 1a-e,g.

Lithium dianion was prepared following the next typical procedure. A solution of methyllithium (12.5 mmol)was dropped into e stirred solution of the suitable enaminone **1a-e,g** (5 mmol) and HMPA (12.5 mmol) in THF (5 ml) at 0°C under nitrogen and then warmed to 30 °C for 30'. The ceased evolution of methane showed the complete formation of dianion. The mixture was cooled at -100 °C and then treated with alkyl halide (7.5 mmol) in THF for 30'. The temperature was allowed to rise to 20 °C then the solution was poured into saturated aqueous ammonium chloride and extracted with diethyl ether. The organic layer was dried, evaporated under reduced pressure and the residue obtained was submitted to HPLC-MS analysis for the determination of the yield of conversion and the diastereomeric excess. Column chromatographic separation of crude material (n-hexane/ethyl acetate, 90:10) furnished the pure diastereomers.

(3S)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-methylcyclopentene **(3*S*)-2aa.**

M.p. 94-95 °C (Hexane) $[\alpha]_D^{20}$ = -459.4 (c=1.1, $CHCl_3$). (Found: C, 82.41; H, 7.73; N, 4.72. $C_{21}H_{23}NO$ requires: C, 82.59; H, 7.59; N, 4.59 %). ^{1}H-NMR δ 1.26 (d, J=7.0, Me-3), 1.48 (dd, J=7.0, 12.2, 1H), 1.61 (d, J=6.72, Ph-CH-Me), 1.70-1.86 (m, 1H), 2.72 (quint., J=7.3, H-3), 2.94 (ddd, J=7.0, 10.4, 13.1, 1H), 4.75 (dq, J=6.7, 8.8, Ph-CH-Me), 7.20-7.45 (m, 8H), 7.65-7.75 (m, 2H), 10.90 (brd, J=8.8, NH). ^{13}C-NMR δ 17.61 (q), 24.74 (q), 29.01 (t), 31.49 (t), 37.59 (d), 53.77 (d), 103.40 (s), 125.28 (d), 127.03 (d) 127.20 (d), 127.64 (d), 128.68 (d), 129.33 (d), 142.01 (s), 144.48 (s), 173.65 (s), 188.40 (s). IR ν_{max}(nujol) 3300 (broad), 1590, 1515, 1315, 1265, 750, 690 cm^{-1}. MS m/z (%): 305 (M+, 43), 290 (9), 200 (80), 105 (100).

(3R)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-methylcyclopentene **(3*R*)-2aa.**

Oil $[\alpha]_D^{20}$ = -596.1 (c 1.0, $CHCl_3$). (Found: C, 82.63; H, 7.70; N, 4.66. $C_{21}H_{23}NO$ requires: C, 82.59; H, 7.59; N, 4.59 %). ^{1}H-NMR δ 0.96 (d, J=7.3, 3H, Me-3), 1.57 (dd, J=12.2, 6.7, 1H), 1.62 (d, J=7.0, 3H, Ph-CH-Me), 1.92-2.07 (m, 1H), 2.50-2.60 (m, 1H), 2.96 (ddd, J=13.1, 10.7, 6.7, 1H), 3.06 (quint., J=7.3, H-3) 4.77 (dq, J=9.8, 6.7, Ph-CH-Me), 7.20-7.43 (m, 8H), 7.65-7.75 (m, 2H), 11.20 (broad d, J=9.8, NH). ^{13}C-NMR δ 17.35 (q), 25.46 (q), 29.03 (t), 31.91 (t), 37.55 (d), 54.26 (d), 102.98 (s), 125.42 (d), 127.10 (d) 127.22 (d), 127.63 (d), 128.62 (d), 129.33 (d), 141.92 (s), 143.76(s), 173.48 (s), 189.02 (s). IR ν_{max}(nujol) 3350 (broad), 1585, 1515, 1315, 1265, 685 cm^{-1}. MS m/z (%): 305 (M+, 54), 290 (11), 200 (83), 105 (100).

(3S)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-ethylcyclopentene **(3*S*)-2ab.**

Oil $[\alpha]_D^{20}$ = -440.1 (c 1.0, $CHCl_3$). (Found: C, 82.91; H, 7.73; N, 4.32. $C_{22}H_{25}NO$ requires: C, 82.72; H, 7.89; N, 4.38 %). ^{1}H-NMR δ 0, 1.03 (t, J=7.3, 3H, Et), 1.50-1.73 (m, 4H), 1.60 (d, J=6.9, 3H, Ph-CH-Me), 2.45-2.55 (m, 2H), 2.87 (dt, J=13.4, 8.8, 1H), 4.70 (dq, J=8.7, 6.9, 1H, Ph-CH-Me), 7.24-7.46 (m, 8H), 7.66-7.74 (m, 2H), 10.86 (broad d, J=8.7, 1H, NH). ^{13}C-NMR δ 12.20 (q), 24.43 (t), 24.55 (q), 27.65 (t), 29.27 (t), 44.56 (d), 53.73 (d), 103.80 (s), 125.15 (d), 126.86 (d), 127.02 (d), 127.46 (d), 128.51 (d), 129.15 (d), 141.88 (s), 144.37 (s), 172.44 (s), 189.18 (s). IR ν_{max}(liquid film) 3300 (broad), 1580, 1515, 1310, 745, 685 cm^{-1}. MS m/z (%): 319 (M+, 24), 214 (56), 105 (100), 77 (25).

(3S)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-buthylcyclopentene **(3*S*)-2ac.**

Oil $[\alpha]_D^{20}$ = -420.1 (c 2.0, $CHCl_3$). (Found: C, 82.81; H, 7.53; N, 4.14. $C_{24}H_{29}NO$ requires: C, 82.95; H, 8.41; N, 4.03 %). ^{1}H-NMR δ 096 (t, J=7.5, 3H, Bu), 1.27-1.53 (m, 4H), 1.53-1.73 (m, 4H), 1.64 (d, J=6.9, 3H, Ph-CH-Me), 2.47-2.64 (m, 2H), 2.84-2.99 (m, 1H), 4.72 (dq, J=8.7, 6.9, 1H, Ph-CH-Me), 7.22-7.46 (m, 8H), 7.68-7.76 (m, 2H), 10.91 (broad d, J=8.7, 1H, NH). ^{13}C-NMR δ 13.89 (q), 22.55 (t), 24.67 (q), 28.16 (t), 29.30

(t), 30.05 (t), 31.07 (t), 42.99 (d), 53.81 (d), 103.84 (s), 125.24 (d), 126.97 (d), 127.14 (d), 127.57 (d), 128.63 (d), 129.26 (d), 142.00 (s), 144.53 (s), 172.89 (s), 189.22 (s). IR ν_{max}(nujol) 3300 (broad), 1600, 1530, 1320, 745, 685 cm^{-1}. MS m/z (%): 347 (M+, 29), 242 (37), 186 (47), 105 (100), 77 (21).

(3R)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-benzylcyclopentene **(3*R*)-2ad.**

Oil $[\alpha]_D^{20}$ = -275.4 (c 1.0, $CHCl_3$). (Found: C, 84.84; H, 7.05; N, 3.60. $C_{27}H_{27}NO$ requires: C, 85.00; H, 7.13; N, 3.67 %). ^{1}H-NMR δ 1.54 (d, J=6.9, 3H, Ph-CH-Me), 1.56-166 (m,2H), 2.40-2.50 (m, 1H, H-3), 2.70-2.90 (m, 3H), 3.02 (dd, J=13.0, 4.4, 1H), 4.57 (dq, J=8.4, 6.9, 1H, Ph-CH-Me), 7.20-7.45 (m, 13H), 7.64-7.72 (m, 2H), 10.85 (broad d, J=8.4, 1H, NH). ^{13}C-NMR δ 24.61 (q), 28.36 (t), 28.97 (t), 37.68 (t), 44.78 (d), 53.88 (d), 104.36 (s), 125.12 (d), 126.25 (d), 126.95 (d), 127.11 (d), 127.57 (d), 128.26 (d), 128.64 (d), 128.82 (d), 129.35 (d), 139.23 (s), 141.82 (s), 144.58 (s), 171.78 (s), 189.50 (s). IR ν_{max}(nujol) 3350 (broad), 1585, 1510, 1310, 740, 685 cm^{-1}. MS m/z (%): 381 (M+, 26), 290 (67), 105 (100), 77 (22).

(3R)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-iso-propylcyclopentene **(3*R*)-2ae.**

Oil $[\alpha]_D^{20}$ = -480.1 (c 2.0, $CHCl_3$). (Found: C, 82.73; H, 7.98; N, 4.32. $C_{23}H_{27}NO$ requires: C, 82.84; H, 8.16; N, 4.20 %). ^{1}H-NMR δ 0.97 (d,J=6.7, 3H, i-Pr), 1.03 (d, J=6.9, 3H, i-Pr), 1.50-1.65 (m, 1H), 1.59 (d, J=6.7, 3H, Ph-CH-Me), 1.68-1.77 (m, 1H), 2.17 (quint d, J=6.7, 3.6, 1H, i-Pr), 2.49 (ddd, J=13.6, 9.3, 1.1, 1H), 2.58 (dd, J=8.5, 3.6, 1H), 2.79 (ddd, J=13.6, 9.8, 7.8, 1H), 4.74 (dq, J=9.0, 6.9, 1H, Ph-CH-Me), 7.20-7.45 (m, 8H), 7.65-7.67 (m, 2H), 11.02 (broad d, J=9.0, 1H, NH). ^{13}C-NMR δ 16.76 (q), 21.70(q), 23.54(t), 24.59(q), 30.42(d), 31.05(t), 48.81(d), 53.79(d), 105.09(s), 125.21(d), 126.87(d), 127.02(d), 127.50(d), 128.55(d), 129.17(d), 142.06(s), 144.45(s), 171.42(s), 189.28(s). IR ν_{max}(nujol) 3300 (broad), 1585, 1520, 1310, 745, 690 cm^{-1}. MS m/z (%): 333 (M+, 36), 290 (26), 228 (36), 186 (20), 105 (100), 77 (23).

(3S)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-iso-propylcyclopentene **(3*S*)-2ae.**

Oil $[\alpha]_D^{20}$ = -417.4 (c 1.0, $CHCl_3$). (Found: C, 82.92; H, 7.94; N, 4.26. $C_{23}H_{27}NO$ requires: C, 82.84; H, 8.16; N, 4.20 %). ^{1}H-NMR δ 0.75 (d,J=6.7, 3H, i-Pr), 0.95 (d, J=7.0, 3H, i-Pr), 1.61 (d, J=6.7, 3H, Ph-CH-Me), 1.80-1.89 (m, 3H), 2.52-2.61 (m, 1H), 2.78-2.90 (m, 1H), 2.94-3.00 (m, 1H), 4.76 (dq, J=10.4, 6.7, 1H, Ph-CH-Me), 7.20-7.40 (m, 8H), 7.64-7.67 (m, 2H), 11.30 (broad d, J=10.4, 1H, NH). ^{13}C-NMR δ 16.22 (q), 21.70(q), 23.53(t), 25.79(q), 30.14(d), 31.38(t), 48.91(d), 54.19(d), 104.70(s), 125.23(d), 127.03(d), 127.16(d), 127.64(d), 128.56(d), 129.28(d), 142.16(s), 143.62(s), 171.21(s), 189.08(s). IR ν_{max}(nujol) 3300 (broad), 1585, 1520, 1310, 745, 690 cm^{-1}. MS m/z (%): 333 (M+, 34), 290 (25), 228 (31), 186 (20), 105 (100).

(3S)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-methylcyclohexene **(3*S*)-2ba.**

M.p. 129-131 °C (Hexane) $[\alpha]_D^{20}$ = -381.5 (c 1.7, $CHCl_3$). (Found: C, 82.61; H, 7.73; N, 4.42. $C_{22}H_{25}NO$ requires: C, 82.72; H, 7.89; N, 4.38 %). ^{1}H-NMR δ 1.33 (d, J=7.2, 3H, Me-3), 1.35-1.63 (m, 4H), 1.59 (d, J=6.7, Ph-CH-Me), 2.15-2.40 (m, 2H), 2.57-2.69 (m, H-3), 4.82 (dq, J=8.7, 6.9, Ph-CH-Me), 7.20-7.45 (m, 10H), 12.40 (broad d, J=8.7, NH). ^{13}C-NMR δ 18.49 (t), 20.66 (q), 24.93 (q), 27.49 (t), 28.80 (t), 29.11 (d), 52.06 (d), 99.75 (s), 125.40 (d), 126.43 (d), 126.93 (d), 127.78 (d), 128.21 (d), 128.74 (d), 143.05 (s), 145.17 (s), 167.90 (s), 195.14 (s). IR ν_{max}(nujol) 3350 (broad), 1570, 1430, 1260, 690 cm^{-1}. MS m/z (%): 319 (M+,17), 302 (10), 215 (19), 214 (100), 105 (74), 77 (18).

(3R)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-methylcyclohexene **(3*R*)-2ba.**

Oil $[\alpha]_D^{20}$ = -272.8 (c 1.0, $CHCl_3$). (Found: C, 82.69; H, 7.82; N, 4.48. $C_{22}H_{25}NO$ requires: C, 82.72; H, 7.89; N, 4.38 %). ^{1}H-NMR δ 1.03 (d, J=7.2, 3H, Me-3), 1.10-1.80 (m, 4H), 1.58 (d, J=6.7, Ph-CH-Me), 2.18-2.40 (m, 2H), 2.91-3.02 (m, 1H), 4.90 (dq, J=9.5, 6.7, Ph-CH-Me), 7.20-7.50 (m, 10H), 12.90 (broad d, J=9.4, 1H, NH). ^{13}C-NMR δ 18.74 (t), 20.35 (q), 2627 (q), 27.28 (t), 28.97 (t), 29.36 (d), 52.15 (d), 98.94 (s), 125.72 (d), 126.51 (d), 127.11 (d), 127.74 (d), 128.13 (d), 128.73 (d), 143.11 (s), 143.95 (s), 167.66 (s), 194.30 (s). IR ν_{max}(nujol) 3300 (broad), 1565, 1435, 1265, 750, 695 cm^{-1}. MS m/z (%): 319 (M+, 17), 302 (9), 215 (18), 214 (100), 105 (91), 77 (22).

(3S)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-ethylcyclohexene **(3*S*)-2bb.**

Oil $[\alpha]_D^{20}$ = -434.6 (c 3.9, $CHCl_3$). (Found: C, 82.73; H, 7.98; N, 4.31. $C_{23}H_{27}NO$ requires: C, 82.84; H, 8.16; N, 4.20 %). ^{1}H-NMR δ 1.03 (t, J=7.5, 3H, Et), 1.21-1.87 (m, 6H), 1.58 (d, J=6.9, 3H, Ph-CH-Me), 2.14-2.36 (m, 3H), 4.72 (dq, J=8.5, 6.8, 1H, Ph-CH-Me), 7.20-7.64 (m, 10H), 11.35 (broad d, J=8.5, 1H, NH). ^{13}C-NMR δ 12.45 (q), 18.84 (t), 24.15 (t), 25.01 (q), 26.93 (t), 27.32 (t), 36.52 (d), 52.40 (d), 100.68 (s), 125.54 (d), 126.60 (d), 127.00 (d), 127.80 (d), 128.31 (d), 128.80 (d), 143.30 (s), 145.30 (s), 168.10 (s), 194.80 (s). IR ν_{max}(nujol) 3350 (broad), 1560, 1430, 1255, 1130, 745, 685 cm^{-1}. MS m/z (%): 333 (M+, 10), 228 (79), 200 (17), 105 (100), 77 (26).

(3S)-1-benzoyl-2-(N-1'(R)-phenylethyl)-amino-3-buthylcyclohexene **(3*S*)-2bc.**

Oil $[\alpha]_D^{20}$ = -466.3 (c 3.6, $CHCl_3$). (Found: C, 82.93; H, 8.73; N, 3.76. $C_{25}H_{31}NO$ requires: C, 83.06; H, 8.64; N, 3.87 %). ^{1}H-NMR δ 097 (t, J=6.9, 3H, Bu), 1.26-1.70 (m, 10H), 1.58 (d, J=6.7, 3H, Ph-CH-Me), 2.15-2.44 (m, 3H), 4.74 (dq, J=8.4, 6.9, 1H, Ph-CH-Me), 7.24-7.46 (m, 10H), 11.38 (broad d, J=8.4, 1H, NH). ^{13}C-NMR δ 14.10 (q), 18.82 (t), 22.73 (t), 24.58 (t), 25.00 (q), 27.25 (t), 30.02 (t), 33.65 (t), 34.80 (d), 52.30 (d), 100.29 (s), 125.51 (d), 126.59 (d), 127.00 (d), 127.80 (d), 128.29 (d), 128.80 (d), 143.14 (s), 145.33 (s), 168.10 (s), 194.87 (s). IR ν_{max}(nujol) 3350 (broad), 1560, 1430, 1255, 1130, 745, 685 cm^{-1}. MS m/z (%): 361 (M+, 4), 256 (36), 200 (63), 105 (100).

(4R)-1-Phenyl-2-(N-1'(R)-phenylethyl)-amino-4-methyl-hex-2-en-1-one **(4*R*)-2cb.**

Oil $[\alpha]_D^{20}$ = -186.5 (c 1.0, $CHCl_3$). (Found: C, 82.13; H, 8.23; N, 4.47. $C_{21}H_{25}NO$ requires: C, 82.04; H, 8.20; N, 4.56 %). ^{1}H-NMR δ 0.85 (d, J=6.7, 3H, Me-4), 0.96 (t, J=7.3, 3H), 1.48-1.65 (m, 2H), 1.63 (d, J=6.9, 3H, Ph-CH-Me), 2.50 (sext, J=6.8, 1H,H-4), 4.85(dq, J=7.2, 6.9, 1H, Ph-CH-Me), 5.76 (s, 1H, H-2), 7.20-7.45 (m, 8H), 7.88-7.98 (m, 2H), 12.35 (broad d, J=7.2, 1H, NH). ^{13}C-NMR δ 11.84 (q), 18.79 (q), 24.80 (q), 29.44 (t), 35.94 (d), 52.46 (d), 87.70 (d), 125.39 (d), 126.64 (d), 127.01 (d), 127.91 (d), 128.60 (d), 130.13 (d), 140.61 (s), 144.37 (s), 173.71 (s), 187.98 (s). IR ν_{max}(nujol) 3350 (broad), 1575, 1270, 735, 685 cm^{-1}. MS m/z (%): 307 (M+, 38), 202 (43), 188 (25), 105 (100), 77 (29).

(4R)-1,5-Diphenyl-3-(N-1'(R)-phenylethyl)-amino-4-methyl-pent-2-en-1-one **(4*R*)-2cd.**

Oil $[\alpha]_D^{20}$ = -505.6 (c=2.4, $CHCl_3$). (Found: C, 84.57; H, 7.49; N, 3.71. $C_{26}H_{27}NO$ requires: C, 84.51; H, 7.37; N, 3.79 %). ^{1}H-NMR δ 0.98 (d, J=6.1, 3H, Me-4), 1.41(d, J=6.7, 3H, Ph-CH-Me), 2.78 (dd, J=11.7, 5.8, 1H, H-5), 2.88 (sext, J=6.6, 1H, H-4), 2.97 (dd, J=11.7, 7.3, 1H, H-5), 4.43 (dq, J=7.2, 6.7, 1H, Ph-CH-Me), 7.21-7.52 (m, 13H), 7.99-8.09 (m, 2H), 12.29 (broad d, J=7.2, 1H, NH). ^{13}C-NMR δ 18.85 (q), 24.31 (q), 36.59 (d), 43.01 (t), 52.21 (d), 87.86 (d), 125.10 (d), 126.22 (d), 126.58 (d), 126.85 (d), 127.87 (d), 128.17 (d), 128.49 (d), 128.57 (d), 130.13 (d), 138.93 (s), 140.44 (s), 144.26 (s), 172.65 (s), 187.77 (s). IR ν_{max}(liquid film) 3350 (broad), 1565, 1430, 1265, 1055, 1740, 685 cm^{-1}. MS m/z (%): 369 (M+, 15), 278 (22), 264 (11), 120 (19), 105 (100), 77 (21).

(4R)-1-Phenyl-2-(N-1'(R)-phenylethyl)-amino-4,5-dimethyl-hex-2-en-1-one **(4*R*)-2ce.**

Oil $[\alpha]_D^{20}$ = -642.4 (c 2.6, $CHCl_3$). (Found: C, 82.33; H, 8.51; N, 4.31. $C_{22}H_{27}NO$ requires: C, 82.20; H, 8.47; N, 4.36 %). ^{1}H-NMR δ 0.81 (d, J=6.7, 3H, Me-4), 0.96 (d, J=6.7, 3H, i-Pr),0.99 (d, J=6.7, 3H, i-Pr), 1.63 (d, J=6.7, 3H, Ph-CH-Me), 1.76 (d sept, J=8.7, 6.7, 1H, i-Pr), 2.25 (d q, J=8.7, 6.7, 1H, H-4), 4.86 (dq, J=7.2, 6.7, 1H, Ph-CH-Me), 5.72 (s, 1H, H-2), 7.20-7.48 (m, 8H), 7.86-7.95 (m, 2H), 12.36 (broad d, J=7.2, 1H, NH). ^{13}C-NMR δ 16.61 (q), 19.78 (q), 21.48 (q), 24.85 (q), 33.42 (d), 41.49 (d), 52.78 (d), 88.60 (d), 125.59 (d), 126.81 (d), 127.15 (d), 128.08 (d), 128.77 (d), 130.28 (d), 140.76 (s), 144.61 (s), 174.05 (s), 187.94 (s). IR ν_{max}(liquid film) 3350 (broad), 1570, 1270, 1055, 735, 685 cm^{-1}. MS m/z (%): 321 (M+, 8), 306 (2), 278 (4), 216 (14), 202 (14), 174 (23), 105 (100), 77 (24).

(4S)-1,5-Diphenyl-3-(N-1'(R)-phenylethyl)-amino-4-methyl-pent-2-en-1-one **(4*S*)-2da.**

Oil $[\alpha]_D^{20}$ = -545.0 (c=1.0, $CHCl_3$). (Found: C, 84.59; H, 7.42; N, 3.81. $C_{26}H_{27}NO$ requires: C, 84.51; H, 7.37; N, 3.79 %). ^{1}H-NMR δ 1.20 (d, J=6.9, 3H, Me-4), 1.66 (d, J=6.9, 3H, Ph-CH-Me), 2.49 (dd, J=13.3, 9.3, 1H, H-5), 2.67 (dd, J=13.3, 5.0, 1H, H-5), 2.78-2.90 (m, 1H, H-4), 4.80 (dq, J=7.1, 6.9, 1H, Ph-CH-Me), 5.87 (s, 1H, C-2), 6.64-6.72 (m, 2H), 7.13-7.52 (m, 11H), 7.92-8.00 (m, 2H), 12.24 (broad d, J=7.1, 1H, NH). ^{13}C-NMR δ 19.31 (q), 25.02 (q), 36.42 (d), 41.39 (t), 52.76 (d), 88.41 (d), 125.60 (d), 126.06 (d), 126.83 (d), 127.28 (d), 128.10 (d), 128.13 (d), 128.80 (d), 128.90 (d), 130.38 (d), 139.05 (s), 140.68 (s), 144.73 (s), 173.26 (s), 189.39 (s). IR ν_{max}(nujol) 3350 (broad), 1570, 1265, 1055, 735, 685 cm^{-1}. MS m/z (%): 369 (M+, 11), 278 (34), 264 (16), 120 (21), 105 (100), 77 (20).

(4S)-1Phenyl-3-(N-1'(R)-phenylethyl)-amino-4-benzyl-hex-2-en-1-one **(4*S*)-2db.**

Oil $[\alpha]_D^{20}$ = -495.4 (c=1.4, $CHCl_3$) (Found: C, 84.53; H, 7.52; N, 3.56. $C_{27}H_{29}NO$ requires: C, 84.56; H, 7.62; N, 3.65 %).. ^{1}H-NMR δ 0.98 (t, J=7.3, 3H, Me), 1.49-1.75 (m, 2H, H-5), 1.66 (d, J=6.9, 3H, Ph-CH-Me), 2.55 (dd, J=13.3, 8.8, 1H, Bn), 2.61 (dd, J=13.3, 5.0, 1H, Bn), 2.61-2.76 (m, 1H, H-4), 4.84 (dq, J=7.2, 6.9, 1H, Ph-CH-Me), 5.88 (s, 1H, H-2), 6.60-6.68 (m, 2H), 7.10-7.18 (m, 3H), 7.26-7.52 (m, 8H), 7.95-8.03 (m, 2H), 12.40 (broad d, J=7.2, 1H, NH). ^{13}C-NMR δ 11.75 (q), 25.06 (q), 26.88 (t), 40.54 (t), 43.56 (d), 52.89 (d), 88.60 (d), 125.66 (d), 125.99 (d), 126.80 (d), 127.24 (d), 128.07 (d), 128.25 (d), 128.86 (d), 129.02 (d), 130.33 (d), 139.05 (s), 140.67 (s), 144.59 (s), 172.33 (s), 188.08 (s). IR ν_{max}(nujol) 3350 (broad), 1570, 1270, 740, 685 cm^{-1}. MS m/z (%): 383 (M+, 4), 292 (20), 250 (14), 120 (16), 105 (100), 77 (19).

(4R)-1-Phenyl-2-(N-1'(R)-phenylethyl)-amino-4-benzyl-5-methyl-hex-2-en-1-one **(4*R*)-2de.**

Oil $[\alpha]_D^{20}$ = -274.0 (c 3.0, $CHCl_3$) (Found: C, 84.71; H, 7.94; N, 3.70. $C_{28}H_{31}NO$ requires: C, 84.59; H, 7.86; N, 3.52 %).. ^{1}H-NMR δ 1.09 (d, J=6.7, 3H, i-Pr), 1.10 (d, J=6.7, 3H, i-Pr), 1.57 (d, J=6.9, 3H, Ph-CH-Me), 1.94 (octet, J=6.7, 1H, i-Pr), 2.61-2.74 (m, 2H), 2.81-2.93 (m, 1H), 4.67 (dq, J=7.2, 6.9, 1H, Ph-CH-Me), 5.80 (s, 1H, H-2), , 6.68-6.75 (m, 2H), 6.95-7.09 (m, 5H), 7.19-7.30 (m, 3H), 7.39-7.50 (m, 3H), 7.89-7.96 (m, 2H), 12.36 (broad d, J=7.2, 1H, NH). ^{13}C-NMR δ 20.28 (q), 20.87 (q), 25.03 (q), 32.00 (d), 36.86 (t), 48.06 (d), 52.67 (d), 90.14 (d), 125.63 (d), 125.89 (d), 126.86 (d), 127.04 (d), 128.14 (d), 128.18 (d), 128.71 (d), 128.77 (d), 130.34 (d), 139.18 (s), 140.86 (s), 144.02 (s), 170.68 (s), 187.44 (s). IR ν_{max}(nujol) 3350 (broad), 1570, 1270, 1055, 735, 685 cm^{-1}. MS m/z (%): 397 (M+, 10), 354 (8), 306 (15), 250 (27), 105 (100), 77 (17).

(4S)-1-Phenyl-2-(N-1'(R)-phenylethyl)-amino-4,5-dimethyl-hex-2-en-1-one **(4*S*)-2ea.**

Oil $[\alpha]_D^{20}$ = -478.4 (c 1.4, $CHCl_3$) (Found: C, 82.33; H, 8.56; N, 4.31. $C_{22}H_{27}NO$ requires: C, 82.20; H, 8.47; N, 4.36 %).. ^{1}H-NMR δ 0.50 (d, J=6.6, 3H, i-Pr), 0.84 (d, J=6.6, 3H, i-Pr), 1.21 (d, J=6.9, 3H, Me-4), 1.62 (d, J=6.7, 3H, Ph-CH-Me), 1.66 (d sept, J=9.2, 6.6, 1H, i-Pr), 2.28 (dq, J=9.2, 6.9, 1H, H-4), 4.80 (dq, J=7.2, 6.7, 1H, Ph-CH-Me), 5.72 (s, 1H, H-2), 7.18-7.24 (m, 8H), 7.85-7.94 (m, 2H), 12.40 (broad d, J=7.2, 1H, NH). ^{13}C-

NMR δ 18.28 (q), 19.81 (q), 21.21 (q), 25.07 (q), 32.23 (d), 41.49 (d), 52.64 (d), 88.14 (d), 125.92 (d), 126.78 (d), 127.26 (d), 128.04 (d), 128.68 (d), 130.21 (d), 140.82 (s), 144.36 (s), 173.88 (s), 187.99 (s). IR ν_{max}(nujol) 3350 (broad), 1570, 1270, 1055, 735, 685 cm^{-1}. MS m/z (%): 321 (M+, 29), 278 (10), 216 (21), 202 (19), 174 (28), 105 (100), 77 (29).

(4R)-1-Phenyl-2-(N-1'(R)-phenylethyl)-amino-4-ethyl-5-methyl-hex-2-en-1-one **(4*R*)-2eb.**

Oil $[\alpha]_D^{20}$ = -604.2 (c 3.0, $CHCl_3$) (Found: C, 82.44; H, 8.79; N, 4.06. $C_{23}H_{29}NO$ requires: C, 82.34; H, 8.71; N, 4.17 %).. ^{1}H-NMR δ 0.42 (d, J=6.7, 3H, i-Pr), 0.85 (d, J=6.7, 3H, i-Pr), 0.98 (t, J=7.3, 3H, Et), 1.47 (dqd, J=13.7, 10.6, 7.3, 1H, Et), 1.56-1.70 (m, 1H, i-Pr), 1.63 (d, J=6.7, 3H, Ph-CH-Me), 1.84 (dqd, J=13.7, 7.3, 4.0, 1H, Et), 4.89 (dq, J=7.2, 6.7, 1H, Ph-CH-Me), 5.70 (s, 1H, H-2), 7.22-7.46 (m, 8H), 7.86-7.92 (m, 2H), 12.66 (broad d, J=7.2, 1H, NH). ^{13}C-NMR δ 11.67 (q), 20.27 (q), 21.17 (q), 25.19 (q), 25.33 (t), 31.94 (d), 48.22 (d), 52.77 (d), 88.44 (d), 126.05 (d), 126.77 (d), 127.24 (d), 128.04 (d), 128.68 (d), 130.18 (d), 140.85 (s), 144.29 (s), 172.47 (s), 187.59 (s). IR ν_{max}(nujol) 3350 (broad), 1570, 1310, 1270, 1055, 735, 685 cm^{-1}. MS m/z (%): 335 (M+, 15), 292 (9), 230 (15), 188 (39), 105 (100), 77 (23).

(4S)-1-Phenyl-2-(N-1'(R)-phenylethyl)-amino-4-benzyl-5-methyl-hex-2-en-1-one **(4*S*)-2ed.**

Oil $[\alpha]_D^{20}$ = -717.3 (c= 1.8, $CHCl_3$) (Found: C, 84.67; H, 7.97; N, 3.77. $C_{28}H_{31}NO$ requires: C, 84.59; H, 7.86; N, 3.52 %).. ^{1}H-NMR δ 0.41 (d, J=6.6, 3H, i-Pr), 1.01 (d, J=6.6, 3H, Ph-CH-Me), 1.04 (d, J=6.7, 3H, i-Pr), 1.81 (d septet, J=9.5, 6.6, 1H, i-Pr), 2.42 (ddd, J=11.3, 9.5, 3.4, 1H, H-4), 2.68 (dd, J= 12.7, 11.3, 1H, Bn), 3.20 (dd, J=12.7, 3.4, 1H, Bn), 3.90 (dq, J=7.2, 6.6, 1H, Ph-CH-Me), 5.90 (s, 1H, H-2), 7.18-7.52 (m, 13H), 7.90-8.04 (m, 2H), 12.44 (broad d, J=7.2, 1H, NH). ^{13}C-NMR δ 20.55 (q), 20.59 (q), 23.97 (q), 31.69 (d), 30.47 (t), 50.10 (d), 52.17 (d), 92.26 (d), 125.67 (d), 126.12 (d), 126.43 (d), 126.74 (d), 127.77 (d), 128.12 (d), 128.20 (d), 128.73 (d), 129.91 (d), 139.11 (s), 140.47 (s), 144.16 (s), 171.75 (s), 186.95 (s). IR ν_{max}(nujol) 3350 (broad), 1570, 1270, 1055, 735, 685 cm^{-1}. MS m/z (%): 397 (M+, 9), 354 (8), 306 (15), 250 (25), 202 (9), 105 (100), 77 (19).

2,7-Diphenyl-5-[N-(R)-1-phenylethyl]-amino-hept-4-en-3-one **4ga.**

Oil $[\alpha]_D^{20}$ = - 402.6 (c= 1.9, $CHCl_3$) (Found: C, 84.67; H, 7.80; N, 3.75. $C_{27}H_{29}NO$ requires: C, 84.56; H, 7.62; N, 3.65 %).. ^{1}H-NMR δ 1.51 (d, J=6.7, 3H, Ph-CH-Me), 1.53 (d, J=7.1, 3H, Me-α'), 2.22-2.47 (m, 2H), 2.50-2.75 (m, 2H), 3.71 (q, J=7.1, 1H, H-α'), 4.60 (dq, J=7.1, 6.7, 1H, Ph-CH-Me), 5.04 (s, 1H, H-α), 6.95-7.04 (m, 2H), 7.18-7.40 (m, 13H), 11.30 (broad d, J=7.1, 1H, NH). ^{13}C-NMR δ 18.20 (q), 24.88 (q), 33.67 (t), 34.25 (t), 51.26 (d), 52.74 (d), 93.84 (d), 125.48 (d), 126.19 (d), 126.21 (d), 127.15 (d), 127.63 (d), 128.09 (d), 128.31 (d), 128.35 (d), 128.77 (d), 140.16 (s), 143.41 (s), 144.47 (s), 165.91 (s), 198.26 (s) IR ν_{max}(film) 3300 (broad), 1570, 1330, 1115, 755, 710, 695 cm^{-1}. MS m/z (%): 383 (M^+, 1), 278 (65), 174 (56), 105 (100)

1,6-Diphenyl-3-[N-(R)-1-phenylethyl]-amino-oct-3-en-5-one **4gb.**

Oil $[\alpha]_D^{20}$ = - 289.5 (c= 1.3, $CHCl_3$) (Found: C, 84.43; H, 7.81; N, 3.76. $C_{28}H_{31}NO$ requires: C, 84.59; H, 7.86; N, 3.52 %).. ^{1}H-NMR δ 0.92 (t, J=7.3, 3H, Me), 1.51 (d, J=6.7, 3H, Ph-CH-Me), 1.75-1.95 (m, 1H, H-β'), 2.05-2.22 (m, 1H, H-β'), 2.22-2.46 (m, 2H), 2.50-2.80 (m, 2H), 3.39 (t, J=7.5, 1H, Hα'), 4.58 (dq, J=7.2, 6.7, 1H, Ph-CH-Me), 5.07 (s, 1H, H-α), 7.00-7.06 (m, 2H), 7.20-7.40 (m, 13H), 11.30 (broad d, J=7.2, 1H, NH). ^{13}C-NMR δ 12.47 (q), 24.83 (q), 26.14 (t), 33.67 (t), 34.30 (t), 52.70 (d), 59.57 (d), 94.50 (d), 125.43 (d), 126.17 (d), 127.06 (d), 127.97 (d), 128.07 (d), 128.18 (d), 128.34 (d), 128.47 (d), 128.68 (d), 140.17 (s), 141.84 (s), 144.33 (s), 165.78 (s), 197.81 (s). IR ν_{max}(film) 3300 (broad), 1570, 1330, 1115, 750, 715, 690 cm^{-1}. MS m/z (%): 397 (M+, 1), 278 (94), 174 (52), 105 (100).

Hydrolysis of the enaminones 2aa,cd,da; synthesis of optically pure 1,3-diketones 3aa,cd,da. The enaminone (2 mmol) dissolved in THF (4 ml) was treated with aqueous 2N HCl (4 ml) and stirr ed at room temperature for 24 h. The mixture was neutralized with natrium carbonate and extracted with dichloromethane. The organic layer was dried, evaporated under reduced pressure and the residue obtained, submitted to chromatographic purifiation (n-hexane/ethyl acetate, 95:5), furnished the optically pure 1,3-diketone in almost quantitative yields (95-98 %). NMR experiment showed that the 1,3 diketones **3aa,cd,da** in $CDCl_3$ solution appear as a mixture of tautomers were the enol form is present at 70 %. For the diketones **3aa** the 30 % ketonic form is present as a mixture of epimers (1*S*,3*S*) and (1*R*,3*S*) in the ratio of 1.6:1.The spectroscopic data of the more abboundant tautomer follows.

***(S)-2-benzoyl-5-Methylcyclopentanone* (*S*)-3aa.**
Oil (Found: C, 76.98; H, 6.82. $C_{13}H_{14}O_2$ requires: C, 77.20; H, 6.98 %). $[\alpha]_D^{20}$ = +14.9 (c= 0.9, $CHCl_3$). ^{1}H-NMR δ .1.20 (d, J=7.02, 3H, Me), 1.40-2.90 (m, 5H), 7.40-7.50 (m, 3H), 7.70-7.80 (m, 2H), 14.40 (broad s, 1H). ^{13}C-NMR δ 14.91 (q), 26.49 (t), 30.61 (t), 42.98 (d), 108.93 (s), 128.05 (d), 128.30 (d), 130.87 (d), 134.50 (s), 168.05 (s), 212.50 (s) . IR ν_{max}(film) 3400 (broad), 1590, 1075, 750, 700 cm^{-1}. MS m/z (%): 202 (M^+, 43), 145 (8), 132 (13), 105 (100), 77 (35).

***(R)-1,5-Diphenyl-4-methyl-pentan-1,3-dione* (*R*)-3cd.**
Mp = 77 °C (hexane) (Found: C, 80.95; H, 6.89. $C_{18}H_{18}O_2$ requires: C, 81.17; H, 6.81 %). $[\alpha]_D^{20}$ = - 90.7 (c= 1.9, $CHCl_3$). ^{1}H-NMR δ.1.22 (d, J=6.7, 3H, Me), 2.68-2.84 (m, 2H, Ph-CH_2), 3.03-3.16 (m, 1H, H-γ), 6.10(s, 1H, H-α), 7.16-7.25 (m, 3H), 7.25-7.35 (m, 2H), 7.41-7.59 (m, 3H), 7.82-7.92 (m, 2H), 16.30 (broad s, 1H, OH) ^{13}C-NMR δ 17.29 (q), 40.04 (t), 45.12 (d), 95.42 (d), 126.24 (d), 126.98 (d), 128.34 (d), 128.55 (d), 129.01 (d), 132.20 (d), 135.05 (s), 139.57 (s), 183.79 (s), 199.48 (s) . IR ν_{max}(film) 3400 (broad), 1595, 1075, 770, 745, 695 cm^{-1}. MS m/z (%): 266 (M^+, 25), 147 (100), 118 (16), 91 (30).

***(S)-1,5-diphenyl-4-methyl-1,3-diketone* (*S*)-3da.**
Mp = 77 °C (hexane) $[\alpha]_D^{20}$ = +91.6 (c= 1.5, $CHCl_3$).

X-ray data collection and structure refinement.

Diffraction data for compounds (γ*S*)-**2ae** and (γ*S*)-**2da** were collected on a Siemens R3m/V automatic four-circle diffractometer, using a graphite-monochromated MoKα radiation. Lattice parameters were obtained from least-squares refinement of the setting angles of 25 reflections in the 14≤ 2θ≤30° range. Lorentz-polarization corrections were applied to the intensity data. The structures were solved by standard direct methods and subsequently completed by Fourier recycling. Non-hydrogen atoms were refined anisotropically. All hydrogen atoms were set in calculated positions and refined as riding atoms, with a common thermal parameter. The final R values were 0.041 [(γ*S*)-**2ae**] and 0.050 [(γ*S*)-**2da**], Rw= 0.048 [(γ*S*)-**2ae**] and 0.053 [(γ*S*)-**2da**]. The weigthing scheme used in the last refinement cycles was w =1.0000/[σ^2(Fo)+q(Fo)^2] were q=0.0015 and 0.0020 for [(γ*S*)-**2ae**] and [(γ*S*)-**2da**] respectively. Solution and refinements were performed with the SHELXL-PLUS system (1989).[11] The final geometrical calculations were performed with the PARST[12] program. Additional material is available from the Cambridge Crystallographic Data Centre comprises H-atom coordinates, thermal parameters, relevant least-squares planes, possible H bonds and remaining bond lengths and angles.

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Supplementary Material Available: Conditions of crystallographic data collection and structure refinement, tables of atom coordinates, thermal parameters, relevant least-squares planes, possible H-bonds, and bond lengths and angles, and the ORTEP drawing (32 pages).

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